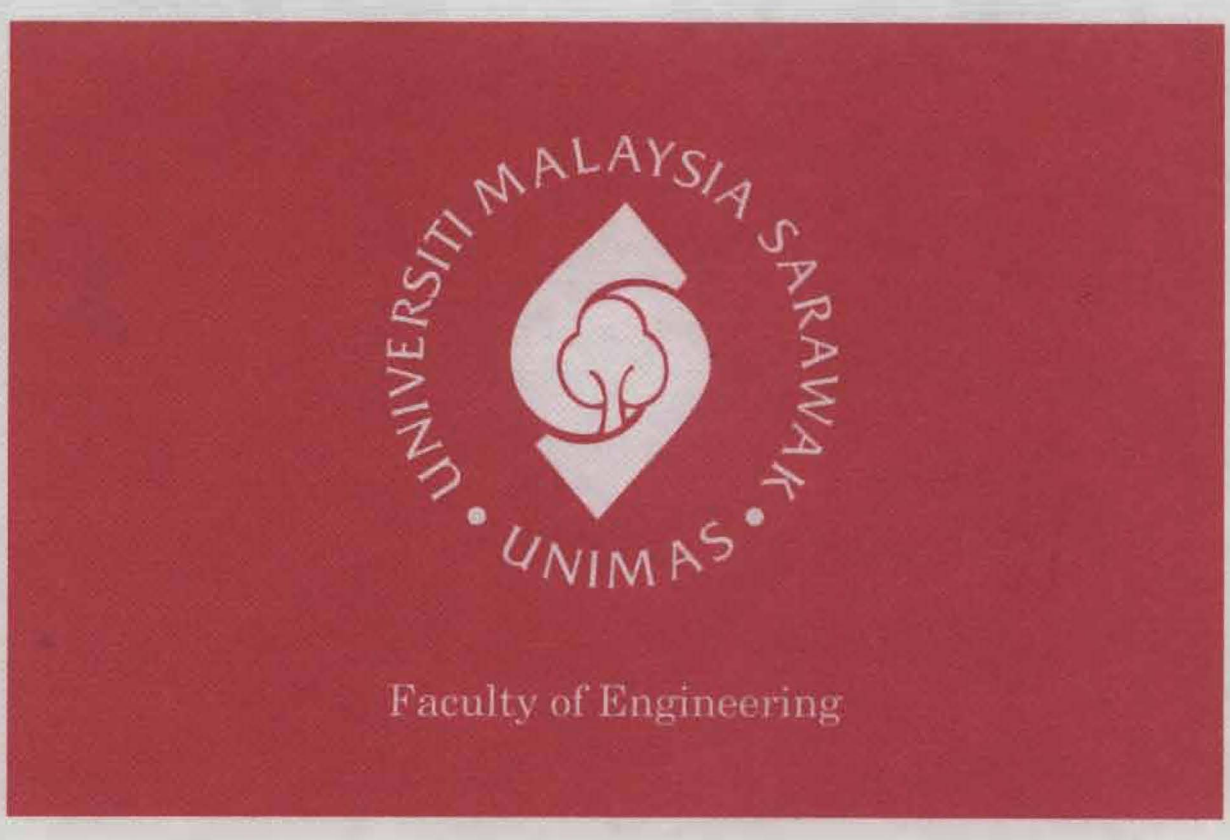

FEASIBILITY STUDY OF SUSTAINABLE PELLET-GASIFICATION - POWER GENERATION IN SARAWAK RURAL AREAS

Albern Anak Tomek

Bachelor of Engineering with Honours
(Mechanical and Manufacturing System Engineering)
2010

UNIVERSITI MALAYSIA SARAWAK

PENGESAHAN TESIS

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Alamat Tetap: 106 Taman Wee & Wee
Jalan Sg Maong
93150 Kuching
Sarawak

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(TANDATANGAN PENULIS) (TANDATANGAN PENYELIA)

Alamat Tetap: 102 Taman Wee & Wee
Jalan Sg Maong
93150 Kuching
Sarawak

EN. NAZERI ABDUL RAHMAN

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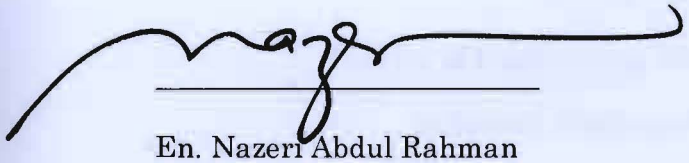

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En. Nazeri Abdul Rahman

(Supervisor)

Date

FEASIBILITY STUDY OF SUSTAINABLE PELLET – GASIFICATION – POWER GENERATION IN SARAWAK RURAL AREAS

ALBERN ANAK TOMEK

Thesis is submitted to

Faculty of Engineering, University Malaysia Sarawak

In Partial Fulfilment of the Requirements

For The Degree of Bachelor of Engineering

With Honours (Mechanical and Manufacturing Engineering)

2010

For my beloved family and friends

Thank you for your supports and encouragements

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ABSTRAK

Malaysia mempunyai sumber biomas dan bahan buangan yang banyak dan sangat berpotensi untuk dijadikan bahan bakar untuk penjanaan tenaga. Kerajaan Malaysia telah meningkatkan dan mempercepatkan pembangunan dan penggunaan tenaga diperbaharui sejajar dengan polisi kerajaan dalam Rancangan Malaysia ke Lapan (2001 – 2005) untuk menggunakan tenaga diperbaharui sebagai sumber bahan bakar kelima. Pengunaan biomass untuk tujuan pengegasan sebagai bahan bakar bagi penjanaan tenaga telah menjadi tumpuan utama di kawasan padat penduduk tetapi kurang tumpuan diberikan di kawasan pedalaman. Usaha telah dijalankan untuk mempelbagaikan penggunaan tenaga diperbaharui supaya bersesuaian dengan permintaan yang semakin meningkat. Oleh yang demikian, penyelidikan ini dijalankan untuk menyelidik kebolehlaksanaan pengegasan biomas untuk tujuan penjanaan kuasa di kawasan pedalaman dengan menggunakan bahan bakar yang dimampat dari sisa buangan pertanian. Hasil daripada penjanaan tenaga elektrik ini juga boleh dijual kepada rangkaian grid nasional untuk memenuhi permintaan semasa. Sebuah perisian telah diprogramkan dalam penyelidikan ini bertujuan untuk mempermudahkan pembuatan keputusan secara lestari dan menganalisa kebolehlaksanaan sistem yang diselidik. Daerah Lundu telah dipilih sebagai lokasi kes kajian untuk tujuan menganalisa kebolehlaksaan sistem. Berdasarkan kajian yang telah dijalankan, pengegasan adalah pilihan yang lestari dan penganalisaan kebolehlaksaan sistem telah ditentukan.

Kata kunci: Pengegasan, Sustainabiliti, Biomas, Elektrifikasi Luar Bandar

ABSTRACT

Malaysia has the potential to utilise the biomass resources for power generation since these resources are abundant. The government has increased and accelerated the development and use of renewable energy in order to meet the fifth fuel policy as announced in Eight Malaysia Plan (2001 – 2005). Utilisation of biomass for gasification to produce fuels for power generation had been implemented in urban or highly populated areas, however, less effort for implementation of such system in rural areas. Due to rapid development, efforts need to be aggressively executed to find ways for utilising renewable energy in order to meet increasing demands of energy. Therefore, this study attempted to investigate the feasibility of implementing biomass gasification for power generation in rural areas through the utilisation of densified solid fuels from agricultural residues. A decision making tool has been chosen in attempt to solve sustainability issues and an analysis tool, in the format of Computer Simulation has been designed and programmed using Microsoft Excel in order to aid the investigation. Lundu district has been chosen as site study to test the software created in order to investigate the feasibility of implementing the system. The result showed that the most sustainable option for this study is gasification system and it is possible to implement pellet – gasification – power generation to the studied site.

Keywords: Gasification, Sustainability, Biomass, Rural Electrification

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ABBREVIATIONS

AHP	Analytical Hierarchy Process
ASEAN	Association of South East Asian Nations
BCSE	Business Council for Sustainable Energy
BEC	Biomass Energy Centre
CGPL	Combustion, Gasification and Propulsion Laboratory
CH_4	Methane
CHP	Combined Heat and Power
CI	Compression Ignition
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CoERE	Centre of Excellence for Renewable Energy
CoERI	Centre of Excellence for Rural Informatics
COGEN	Cogeneration
DOA	Department of Agriculture
DPPEA	Division of Pollution Prevention and Environmental Assistance
EC	European Commission
EFB	Empty Fruit Bunch
EIB	Energy Information Bureau
ELECTRE	Elimination and Choice Translating Reality
EPC	European Pellet Centre
EUBIA	European Biomass Industry Associations
FAO	Food and Agricultural Organization

FFB	Fresh Fruit Bunch
FSDP	Full-Scale Demonstration Projects
GHGs	Greenhouse Gases
H_2	Hydrogen
H_2O	Water
HRSG	Heat Recovery Steam Generator
IC	Internal Combustion
ICE	Internal Combustion Engine
IEA	Internal Energy Agency
Kpg.	Kampung
LDO	Lundu District Office
LPG	Liquefied Petroleum Gas
MADM	Multiple Attribute Decision Making
MAUT	Multi-Attribute Utility Theory
MC	Moisture Content
MCDM	Multiple-Criteria Decision Making
NREL	National Renewable Energy Laboratory
NVC	Net Calorific Value
O_2	Oxygen
PROMETHEE	Preference Ranking Organization Method for Enrichment Evaluation
RPM	Revolution Per Minute
SI	Spark Ignition
SK	Sekolah Kebangsaan
SREP	Small Renewable Energy Power

TOPSIS	Technique for Order Preference by Similarity to Ideal Solutions
UK	United Kingdom
UNDP	United Nation Development Programme

NOMENCLATURES

η_{Gas}	Efficiency of Gasifier (%)
η_{engine}	Efficiency of the Engine (%)
Ø	Diameter
A	Total Area of Biomass Plantation (hectare)
Asp	Aspect
$\overline{Asp}$	Normalized Matrix of Aspect
Asp C	Summation of Aspect Column
cm	Centimetre
Cri	Criteria
$\overline{Cri}$	Normalized Matrix of Criteria
Cri C	Summation of Criteria Column
$CriOpt$	Criteria of Option
$CV_{biomass}$	Average Calorific Value of Biomass (kJ/kg)
CV_{CH}	Average Calorific Value for Coconut Husk (kJ/kg)
CV_{CS}	Average Calorific Value for Coconut Shell (kJ/kg)
CV_{CF}	Average Calorific Value for Coconut Tree Frond (kJ/kg)
CV_{EFB}	Average Calorific Value of EFB (kJ/kg)
CV_{F}	Average Calorific Value of Pruning Frond (kJ/kg)
CV_{Gas}	Average Gas Heating Value
CV_{PS}	Average Calorific Value for Paddy Straw
CV_{RH}	Average Calorific Value for Rice Husk
D	Decision Maker
$\overline{D}$	Normalized Matrix of Decision Maker